

SECTION 8

COMPUTER MODEL FOR HYDROLOGIC DESIGN

The model developed in this project provides a comprehensive analysis of flow and storage in porous pavements. Although the model is not very complex, limited tests indicate that it can adequately quantify the hydrologic responses of a porous pavement. Also, the effects of different pavement characteristics can be evaluated. This allows for the investigation of various porous pavement systems to determine the optimum system, particularly during planning phases of a project.

The hydrologic responses of a porous pavement may be simulated by a system of hydraulically connected control volumes for which the inflows and outflows are mathematically defined. The porous pavement, the base and the natural ground (or the drain system) are considered to be sequential but internally independent storage reservoirs.

The basic equation of continuity of conservation of mass is applied to each reservoir:

$$\frac{ds}{dt} = I - O$$

where

I = inflow into the reservoir

O = outflow from the reservoir

$\frac{ds}{dt}$ = change in storage volume

Inflows to the Porous Pavement System

As shown in Fig. 3, the porous pavement area would serve to control runoff from contributing impervious areas. Therefore, inflow to the porous pavement system, RUNOFF, is defined as:

$$\text{RUNOFF} = \text{PAV} + \text{HYD}$$

where:

PAV = direct rainfall onto the porous pavement

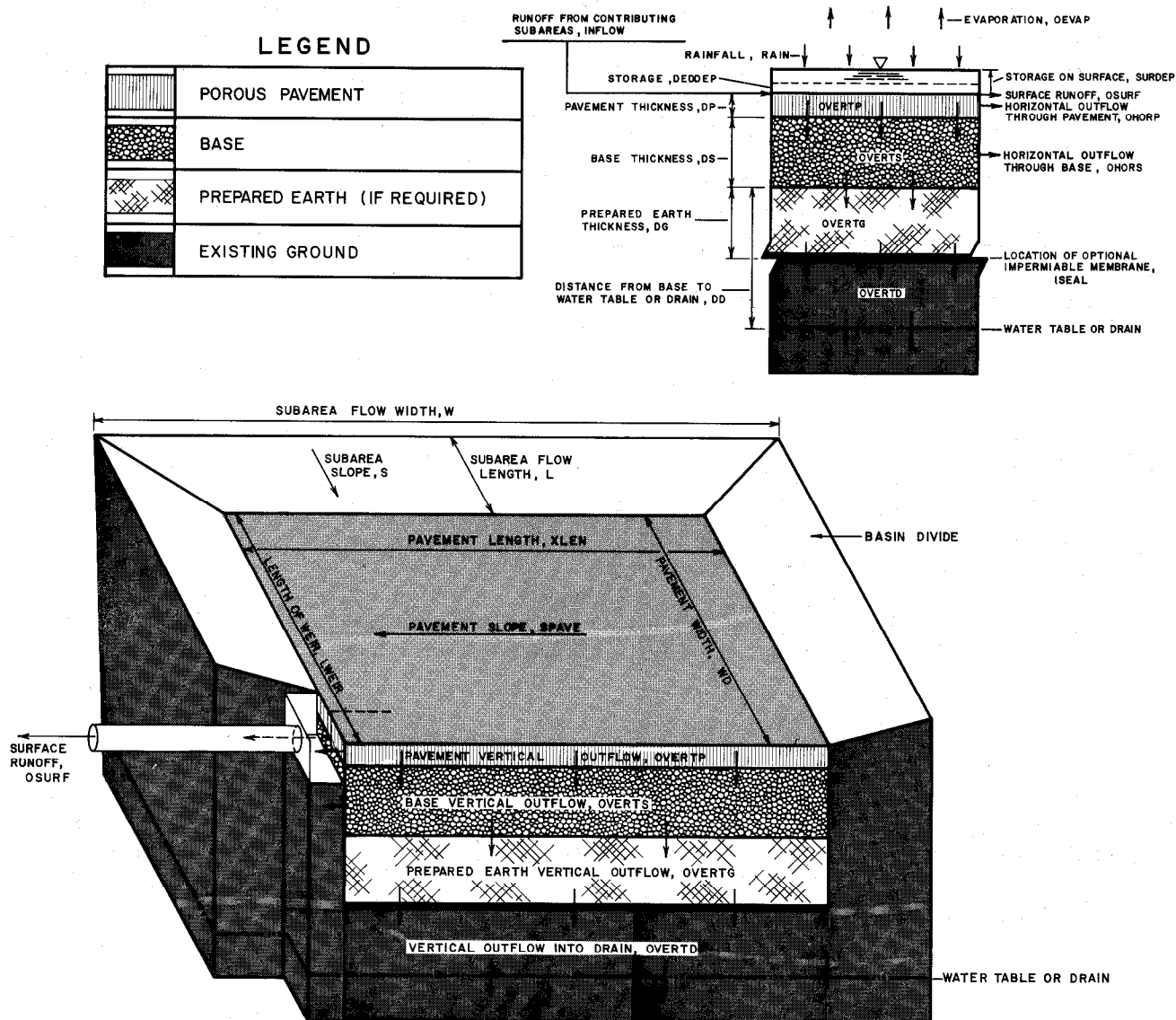


FIGURE 3 HYDROLOGIC MODEL PARAMETERS FOR POROUS PAVEMENTS

HYD = surface runoff hydrograph from contributing areas

Contributing areas to the porous pavement will generally be developed and impervious in nature. Consequently, the surface runoff hydrograph from contributing areas is determined by use of the method developed by Izzard (18). This method, selected for its programming ease, utilizes a dimensionless hydrograph from paved areas as shown in Fig. 4. The key parameters in this method are time to equilibrium, t_e ; equilibrium flow, q_e ; equilibrium surface detention volume, V_e ; the intensity of rainfall, i ; and the length of overland flow, L . The following equations define these parameters:

$$q_e = \frac{wiL}{43200}$$

where:

- q_e = equilibrium flow, cfs
- i = rainfall intensity, inches per hour
- L = length of overland flow, feet
- w = width of overland flow, feet.

$$V_e = \frac{kL^{1.33}i^{0.33}}{35.1}$$

where:

- V_e = equilibrium surface detention volume, cu. ft.
- k = an empirically derived, lumped coefficient for the effects of slope and flow retardance of the pavement

$$t_e = \frac{V_e}{30 q_e}$$

- t_e = time to equilibrium, minutes

Using t/t_e values based on the computation interval and Fig. 4, the q/q_e values and the corresponding q values are determined for the rising limb of the hydrograph.

The β factor, defined as

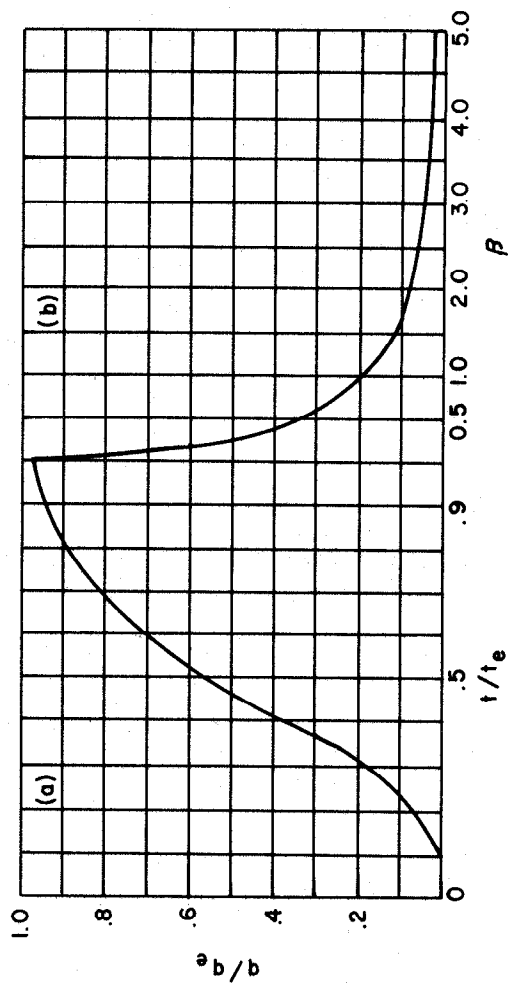


FIGURE 4

IZZARD'S DIMENSIONLESS HYDROGRAPH OF OVERLAND FLOW

$$\beta = \frac{60 q_e t_a}{V_o}$$

where

t_a = time after rainfall has ceased, minutes

V_o = equivalent to V_e without the rainfall intensity component, cu. ft.

is used to determine the q/q_e and corresponding q values for the recession limb of the hydrograph.

If the duration of rainfall is greater than the time required to reach flow equilibrium, ($t_e < t < t_a$), then the q/q_e value remains at a constant value of 0.97 until t_a .

The rainfall hyetograph is input as average intensity per hour for all intervals during which rainfall occurs. Runoff hydrographs are computed for each interval, successively, and summed to determine the cumulative storm hydrograph from contributory areas to the porous pavement. The inflow hydrograph is converted to units of depth based on the area of the porous pavement and computation interval. The rainfall depth onto the porous pavement, PAV, is added to surface runoff depth, HYD, to determine RUNOFF. An alternative user optional input table of RUNOFF depths per computation interval may also be utilized. This option is useful in those instances where storm hydrograph data are available from observation or computed by other methods.

Outflows from the Porous Pavement System

As considered in this model, the outflows from the porous pavement system are composed of four outflow functions defined as follows:

$$OTOTAL = OVERT + OHOR + OSURF + OEVP$$

OVERT is the vertical seepage into the pavement, base, or ground. This seepage is determined as the difference in surface water depth at the beginning and end of each time interval. The variable head permeability equation as defined by Taylor (19) is:

$$K = 2.3 \frac{aL}{A \Delta t} \log \frac{h_1}{h_2}$$

where:

K = permeability of flow element, ft/sec

a = cross-sectional area of surface water, sq ft

A = cross-sectional area of flow element, sq ft

L = thickness of flow element, ft

h_1 = depth of surface water at time t_1 , ft

h_2 = depth of surface water at time $t_2 = t_1 + \Delta t$, ft

These parameters are graphically depicted in Fig. 3.

In a porous pavement system, the cross-sectional areas of surface water and flow elements are always equal, and so the equation is reduced to:

$$K = 2.3 \frac{L}{\Delta t} \log \frac{h_1}{h_2}$$

This equation may be rearranged to solve for h_2 as follows:

$$h_2 = \frac{h_1}{10^E}$$

where

$$E = \frac{K \Delta t}{2.3L}$$

Then, vertical seepage is equal to the change in water depth during Δt or,

$$\text{OVERT} = h_1 - h_2$$

OHOR is the lateral outflow to a drain or into the natural ground as a result of water storage in the base and pavement. This condition is analogous to bank recharge from a rising stream. In most porous pavement systems, lateral outflow will be negligible because $\text{OVERT} \gg \text{OHOR}$. However if this condition is not met as in Class C or D soils, then OHOR may be a significant factor. For a homogenous isotropic aquifer of finite width, the influence of each increment of rise in the stream is determined by the following set of equations (20):

$$\frac{d^2 h}{dx^2} = \frac{S}{T} \frac{dh}{dt}$$

$$h(0,t) = 0 \text{ for } t \leq 0$$

$$h(0,t) = \Delta H_i \text{ for } t > 0$$

$$\frac{dh(L,t)}{dx} = 0$$

$$h(x,0) = 0$$

where

h = hydraulic head or water depth, ft

x = distance from boundary, ft

S = coefficient of storage of aquifer

T = aquifer transmissivity, cfs/ft

ΔH_i = change in water depth at boundary, ft

L + distance to impermeable boundary or discharge point, ft.

ΔH_i is the increase in stored water depth as a result of vertical drainage from an upper storage volume (previous OVERT). If ΔH_i is negative (after inflow has ceased) water will drain back into the storage volume from the surrounding natural ground. If ΔH_i is 0 then OHOR = 0.

Integrate the first equation and apply boundary conditions to get:

$$\frac{dh}{dx} = \frac{S}{T} \frac{dh}{dt} x$$

The Darcy flow equation can be extended by continuity to define net flow rate as follows:

$$V = K \frac{dh}{dx}$$

$$Q = K A \frac{dh}{dx} = K h w \frac{dh}{dx}$$

$$q = \frac{Q}{w} = K h \frac{dh}{dx} = T \frac{dh}{dx}$$

where:

- V = velocity of flow, ft/sec
- K = permeability of flow element, ft/sec
- $\frac{dh}{dx}$ = change in hydraulic grade, ft/ft
- Q = total mass flow rate, cfs
- A = total flow area, sq. ft.
- h = depth of flow, ft.
- w = width of flow, ft.
- q = flow rate per unit width, cfs/ft
- T = transmissivity of flow element, cfs/ft

Then by substitution:

$$q = T \frac{S}{T} \frac{dh}{dt} x = S \frac{dh}{dt} x$$

define:

$$\frac{dh}{dt} = \frac{h_1 - h_2}{\Delta t} \quad \text{for } x \approx 1.0 \text{ ft}$$

and S is the storage coefficient of the natural ground. At a distance x from the porous pavement boundary, the discharge per unit width is defined as:

$$q = S \left(\frac{h_1 - h_2}{\Delta t} \right) x$$

Because the volume of flow remaining is the only item of interest, the value of x was arbitrarily set equal to 1.0. Then, lateral outflow,

$$\text{OHOR} = q P \Delta t = S \left(\frac{h_1 - h_2}{\Delta t} \right) P \Delta t$$

where:

P = pavement perimeter, ft.

Figure 3 shows how these parameters apply to porous pavement areas. OSURF is the surface runoff resulting from ponding on top of the porous pavement, which occurs either because the inflow rate is greater than the porous pavement permeability or the total storage capacity in the porous pavement system is exceeded. The model requires a depth-storage relationship to determine when the storage is exceeded. On a horizontal pavement, the model determines the depth-storage relationship by use of input pavement and base depths and porosities; on a sloping pavement, this relationship has to be independently computed and input to the model.

The surface runoff from a horizontal pavement is defined by the weir equation:

$$OSURF = CLH^{1.5}$$

where:

C = input weir coefficient

L = input weir length, ft.

H = $h - h_0$, ft.

h_0 = depth of dead surface storage on the porous pavement, ft.

h = depth of flow on the porous pavement, ft.

On a sloping porous pavement, Manning's Equation is used to determine the surface runoff:

$$OSURF = y L \frac{1.486}{n} y^{1.33} s^{0.5}$$

where:

y = computed depth of flow, ft.

t = width of flow, ft.

n = input roughness coefficient

s = input energy slope, ft/ft

OEVAP is the volume of water lost to evaporation. This water loss is computed during and after a storm if water remains on the surface i.e. the pavement is flooded. Although the loss during a storm may be negligible, ponded surface water loss after a storm may be significant particularly in arid climates.

Either monthly, weekly or daily evaporation rates may be input to the model; the monthly and weekly rates are divided into average daily rates. The daily evaporation rate may be increased by an input ratio to allow for heat absorption by the dark asphalt. The model only allows for evaporation from 6 a.m. to 8 p.m., with the maximum rate at 2 p.m. As shown in Fig. 5, a triangular distribution of evaporation is developed by the model by use of the equation:

$$E_p = \frac{E_t}{7}$$

where:

E_p = peak evaporation rate, in/hr

E_t = total daily evaporation, in

for $0 < t_c \leq 6$, $E = 0$

for $6 < t_c \leq 14$, $E = E_p \left(\frac{t_c - 6}{8} \right)$

for $14 < t_c \leq 20$, $E = E_p \left(\frac{20 - t_c}{6} \right)$

for $20 < t_c \leq 24$, $E = 0$

where:

t_c = clock time, hours

E = instantaneous evaporation rate

Model Operation

The paths of water flow through the porous pavement system are shown in Fig. 3. For each computational time interval, all inflows and outflows are accounted for. The total runoff hydrograph, in inches per computational time interval, is either input to the model or may be computed as the sum of runoff hydrographs from contributory areas and direct rainfall onto the pavement as described previously.

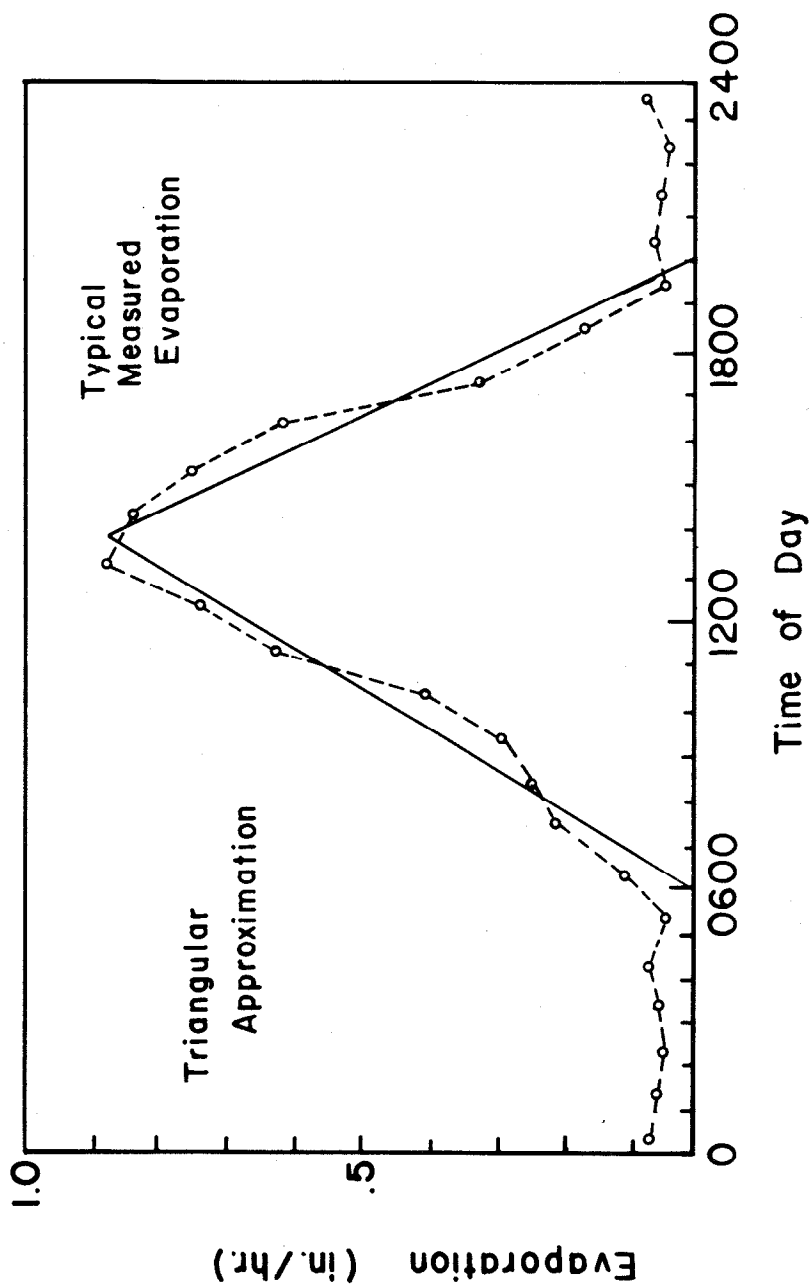


FIGURE 5
TRIANGULAR APPROXIMATION OF EVAPORATION

The following sequential computational steps are then performed:

1. Evaporation losses in inches per computational time interval are computed and subtracted from the sum of the runoff depth and previous surface storage, if any.
2. The volume of runoff after allowing for evaporation is compared to the permeability in inches per time interval of the porous pavement. In general, the permeability is much greater than the inflow runoff rate and all of the water moves into the pavement control volume. In those cases where the permeability has been severely reduced and is less than the runoff rate, the inflow into the pavement and the excess is stored on the surface of the pavement for later computation of surface runoff from the pavement.
3. The inflow into the pavement control volume is added to the storage volume in the pavement and then compared to the permeability, in inches per computational time interval, of the base. If the base permeability is greater than the inflow into the pavement, then all of the flow is transferred into the base control volume. This is true for most porous pavement systems operating according to design. In those instances where the base permeability is less than the inflow volume, the inflow into the base is computed as the vertical seepage into the base. The lateral outflow from the pavement is also computed if an impermeable membrane is not installed along the pavement perimeter. The difference between the inflow into the pavement and the outflows (vertical and lateral) from the pavement is stored in the pavement.
4. The inflow into the base control volume is added to the storage volume in the base and then compared to the permeability in inches per computational time interval, of the natural ground. If the bottom is sealed with an impermeable membrane, then the permeability is set equal to zero, and no flow is lost to the natural ground. The flow volume remaining in the base after vertical seepage into the natural ground is compared to the drain capacity, in inches per computational time interval. If the natural ground permeability and/or drain capacity are inadequate to remove all of the flow in the base, the vertical seepage into the natural ground and drains, as well as the lateral outflow, if any, is computed. The difference between the inflow into the base and the outflows (vertical and lateral) from the base is stored in the base.
5. All stored volumes are compared to available volumes. If storage volume in the base is exceeded, the excess is stored in the pavement; if storage volume in the pavement is exceeded, the

excess is added to the surface storage on the pavement, if any exists. Surface runoff is then computed either as broad channel flow or weir flow from the pavement to an adjacent drainageway.

This computational procedure is repeated for every time interval in the inflow hydrograph. The surface and drain outflows are stored in retrievable arrays. The primary output objective is the surface runoff, if any. However, the other output variables allow for a thorough examination of the hydraulic operational characteristics of the porous pavement system, including the analysis of the desirability or adequacy of the drains and the discharge rate from the drains.

REFERENCES

1. Thelen, E., et al., "Investigations of Porous Pavements for Urban Runoff Control," EPA 11034 DUY 03/72, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1972, 141 pp.
2. "When It Rains, It Pours Through the Pavement," Engineering News Record, Oct. 11, 1973, 38 pp.
3. Diniz, E. V., and W. H. Espey, Jr., "Maximum Utilization of Water Resources in a Planned Community - Application of the Storm Water Management Model," EPA - 600/2-79-050C, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1979.
4. Hollinger, R. H., "Maximum Utilization of Water Resources in a Planned Community - Field Evaluation of Porous Paving," EPA - 600/2-79-050E, U.S. Environmental Protection Agency, Cincinnati, Ohio, (pending publication).
5. Diniz, E. V., "Water Quality Prediction for Urban Runoff - An Alternative Approach," Proceedings of the SWMM User's Group Meeting, EPA 600/9-79-026, U.S. Environmental Protection Agency, Washington, D.C. 1979.
6. Sartor, J. D., and G. B. Boyd, "Water Pollution Aspects of Street Surface Contaminants," EPA-R2-72-081, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1972.
7. Colston, N. V., Jr., and A. N. Tafuri, "Characterization and Treatment of Urban Land Runoff," EPA - 620/2-74-096, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1974.
8. "Train Cites Need to Control Non Point Sources by Land Management," Clean Water Report, 1975, p. 212.
9. Brater, E. F., "Rainfall - Runoff Relations on Urban and Rural Areas," EPA - 670/2-75-046, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1975.
10. Espey, W. H., Jr., et al., "A Study of Some Effects of Urbanization on Storm Runoff from a Small Watershed," Technical Report HYD 07-6501, Center for Research in Water Resources, University of Texas at Austin, 1965.

11. McPherson, M. B., "Urban Runoff," Technical Memoir No. 18, ASCE Urban Water Resources Research Program, 1972.
12. Jones, M. P., "Friction Overlay Improves Runway Skid Resistance," Civil Engineering - ASCE, 1973, pp. 45-48.
13. Asphalt Institute Quarterly, October, 1957.
14. Cedergren, H. R., and K. A. Godfrey, Jr., "Water: Key Cause of Pavement Failure?," Civil Engineering - ASCE, September, 1974, pp. 78-82.
15. Thelen, E., and L. F. Howe, "Porous Pavement," The Franklin Institute Press, Philadelphia, Pennsylvania, 1978, 98 pp.
16. Johnson, E. A., and T. D. White, "Porous Friction Course Solves Airport Hydroplaning Problem," Civil Engineering - ASCE, April, 1976, pp. 90-92.
17. Diniz, E. V., "Quantifying the Effects of Porous Pavements on Urban Runoff," Proceedings of the National Symposium on Urban Hydrology, Hydraulics, and Sediment Control, University of Kentucky, Lexington, Kentucky, 1976.
18. Izzard, C.F. "Hydraulics of Runoff from Developed Surfaces," Proceedings Highway Research Board, Vol. 26, pp. 129-150, 1946.
19. Taylor, D.W. "Permeability," Chapter 6 in Fundamentals of Soil Mechanics, John Wiley & Sons, 1965.
20. Pinder, G.F., J.D. Bredehoeft, and H.H. Cooper, Jr. "Determination of Aquifer Diffusivity from Aquifer Response to Fluctuations in River Stage," Water Resources Research, Vol. 5, No. 4, August 1969.

APPENDIX A

SAMPLE SPECIFICATIONS FOR POROUS ASPHALT PAVEMENT

The following sample specifications are presented in this report to assist the specification writer for whom porous pavement construction is a new area of practice. These specifications will have to be tailored to individual area needs, but sufficient detail is provided so that only minimal changes will have to be made. Consequently, these specifications may have to be reduced in some cases, but precautions must be taken to assure that a contractor understands the exact scope of work, particularly if this is the first attempt at porous pavement construction.

ITEM A: SUBGRADE PREPARATION FOR POROUS PAVEMENT

A.1 DESCRIPTION

The work covered by this item consists of scarifying, blading, and rolling the subgrade to obtain a uniform texture and provide as nearly as practicable a uniform density for the top six inches of the subgrade.

A.2 CONSTRUCTION METHODS

The subgrade shall be shaped in conformity with the typical sections shown on the plans and to the lines and grades established by the Engineer by the removal of existing material or addition of approved material. All unsuitable or otherwise objectionable material shall be removed from the subgrade and replaced with approved material. All holes, ruts and depressions shall be filled with approved material. The surface of the subgrade shall be finished to the lines and grades as established, and be in conformity with the typical sections shown on the plans. Any deviation in excess of one-half ($\frac{1}{2}$) inch (1.27 cm) cross-section and in a length of sixteen (16) feet (4.9 m) measured longitudinally shall be corrected by loosening, adding, or removing material, reshaping and compacting by sprinkling and rolling if required to attain but not exceed the density of the natural subgrade. Sufficient subgrade shall be prepared in advance to ensure satisfactory prosecution of the work. The contractor will be required to set blue tops for the subgrade on center-line, at quarter points and curb lines at intervals not exceeding fifty (50) feet (15.2 m).

Material removed may be utilized in the addition of material to the subgrade if approved by the Engineer. All other material required for the completion of the subgrade shall also be subject to approval by the Engineer.

The type of equipment used in subgrade preparation construction shall not cause undue subgrade compaction. Traffic over subgrade shall be kept at a

minimum. Where fill is required, it shall be compacted to a density equal to the undisturbed subgrade, and inherent soft spots corrected.

A.3 MEASUREMENT

All acceptable subgrade preparation will be measured by the square yard as the area for the entire width of the roadway plus twelve inches (30.5 cm) behind each curb for the entire length.

A.4 PAYMENT

This item shall be paid for at the contract unit price bid for "Subgrade Preparation for Porous Pavement," which price shall be full compensation for all work herein specified, including the furnishing of all materials, equipment, tools, and labor and incidentals necessary to complete the work.

Payment shall be made under:

Pay Item No. 240: Subgrade Preparation for Porous Pavement - Per Square Yard (m^2).

ITEM B: STONE BASE COURSE FOR STORMWATER STORAGE

B.1 DESCRIPTION

"Stone Base Course for Stormwater Storage" shall consist of a foundation course for surfacing, pavement or other base courses; shall be composed of crushed stone or gravel, and shall be constructed as herein specified in two courses in conformity with the typical sections shown on the plans and to the lines and grades as established by the Engineer.

B.2 MATERIAL

The material shall be crushed as necessary to meet the requirements herein-after specified, and shall consist of durable stone or gravel, crushed and/or screened to the required particle size. The material shall be from approved sources.

Testing of flexible base materials shall be in accordance with the following Texas Highway Department standard laboratory test procedures:

- | | | |
|----|---|-----------|
| 1) | Preparation for Soil Constants and Sieve Analysis | TEX-101-E |
| 2) | Sieve Analysis | TEX-110-E |
| 3) | Wet Ball Mill | TEX-116-E |

Unless otherwise specified on the plans, all base material will be stockpiled after crushed; tested by the testing agency designated by the City of _____ and approved by the City of _____ prior to being hauled to the project site.

The material, when properly tested, shall meet the following requirements:

<u>Course</u>	<u>Sieve Size</u>	<u>Retained on Sieve, Percent</u>
Stone Base Course	2½"	0
	1½"	100
Stone Top Course	5/8"	0
	3/8"	100

Max. Wet Ball Mill

50

Unless otherwise shown on plans, the maximum increase in material passing the Number 40 sieve resulting from the Wet Ball Mill Test shall not exceed 20.

B.3 CONSTRUCTION METHODS

(1) Preparation of Subgrade

The street shall be prepared and shaped in conformity with Item 240, "Subgrade Preparation for Porous Pavement" and the typical sections shown on plans and to the lines and grades as established by the Engineer. The surface of the subgrade shall be finished to line and grade as established and in conformity with the typical section shown on plans, and any deviation in excess of ¼ inch (0.6 cm) in cross-section and in a length of 10 feet (3.0 m) measured longitudinally shall be corrected by loosening, adding or removing material and reshaping. Sufficient subgrade shall be prepared in advance to ensure satisfactory prosecution of the work. Material excavated in the preparation of the subgrade shall be utilized in the construction of slopes or otherwise disposed of as directed, and any additional material required for the completion of slopes shall be secured from sources indicated on plans or designated by the Engineer. Blue tops shall be set by the contractor for subgrade on centerline, quarter points and curb lines at intervals not exceeding 50 feet (15.2 m).

(2) Stone Base Course

Immediately before placing the stone base material, the subgrade shall be checked as to conformity with grade and section.

The material shall be delivered in approved vehicles of a uniform capacity and it shall be the charge of the Contractor that the required

amount of specified material shall be delivered in each 100-foot (30.5 m) station.

Stone base course shall be laid over a dry subgrade to the depth shown in drawings, in lifts to lay naturally compacted. The stone base course is not to be rolled or compacted and is to be kept clean from debris, clay, and eroding soil.

(3) Stone Top Course

This course is to be two inches in depth. Construction methods shall be the same as prescribed for the stone base course. Blue tops shall be set by the contractor for finished base grade on center-line and intermediate points not exceeding 11 feet (3.4 m) between points at 50-foot (15.2 m) intervals.

B.4 MEASUREMENT

"Stone Base Course" including the "Stone Top Course" will be measured by the square yard (m^2) at depths specified in the proposal for the area of Parking Lot as shown on the typical sections of the plans or otherwise provided for in the contract documents, complete in place; by the cubic yard (m^3), loose vehicle measurement; or by the cubic yard (m^3), complete in place, as indicated in the proposal.

B.5 PAYMENT

This item will be paid for at the contract unit price bid for "Stone Base Course," which price shall be full compensation for all work herein specified, including the furnishing, hauling, and placing of all materials, for all water required and for all equipment, tools, labor and incidentals necessary to complete the work.

Payment will be made under:

- Pay Item No. 250-A: Stone Base Course (complete in place) - Per Square Yard (m^2), or
- Per Item No. 250-B: Stone Base Course (loose vehicle measurement) - Per Cubic Yard (m^3), or
- Pay Item No. 250-C: Stone Base Course (complete in place) - Per Cubic Yard (m^3).

* This item must be verified for local requirements and site conditions.

ITEM C: HOT MIX POROUS ASPHALT PAVEMENT

C.1 DESCRIPTION

This item shall consist of a surface course as shown on the plans, composed of a lightly compacted mixture of mineral aggregate and asphaltic material.

The pavement shall be constructed on the previously completed and approved subgrade and stone base course as herein specified and in accordance with the details shown on the plans.

C.2 MATERIALS

(1) Coarse Aggregate

The mineral aggregate shall be composed of a coarse aggregate, a fine aggregate, and if required, a mineral filler. Samples of coarse aggregate and mineral filler shall be submitted for testing as directed by the Engineer and approval of both material and of the source of supply must be obtained from the Engineer prior to delivery.

(a) Coarse Aggregate

Coarse aggregate shall be that part of the aggregate retained on the No. 8 sieve; shall consist of clean, tough, durable fragments of crushed stone, or crushed gravel, as hereinafter specified of uniform quality throughout.

When the coarse aggregate is tested in accordance with Test Method Tex-217-F* (Part I, Separation of Deleterious Material), the amount of organic matter, clay, loam or particles coated therewith or other undesirable materials shall not exceed two percent and when remaining part of the sample is further tested in accordance with Test Method Tex-127-F* (Part II, Decantation), the amount of material removed shall not be more than two percent.

The coarse aggregate shall have an abrasion of not more than forty percent loss by weight when subjected to the Los Angeles Abrasion Test, Test Method Tex-410-A*.

Unless specified otherwise, gravel shall be so crushed that seventy-five percent of the particles retained on the No. 4 sieve shall have more than one crushed face when tested in accordance with Test Method Tex-413-A* (Particle Count).

(b) Fine Aggregate

The fine aggregates shall be that part of the aggregate passing the No. 8 sieve and shall consist of sand, screenings, or combination thereof as hereinafter specified of uniform quality throughout.

Fine aggregate shall consist of durable particles, free from injurious foreign matter. Screenings shall be of the same or similar materials as specified for coarse aggregate. The plasticity index of that part of the fine aggregate passing the No. 40 sieve shall be not more than 6 when tested in accordance with Test Method Tex-106-E*. Fine aggregate from each source shall meet plasticity requirements.

Where stone screenings are specified for use, the stone screenings shall meet the following grading requirements unless otherwise shown on plans:

	<u>Percent by Weight</u>
Passing the ½" Sieve	100
Passing the No. 200 Sieve	10-30

When authorized by the Engineer, stone screenings containing particles larger than ½" may be used but only that portion of the material passing the 3/8" sieve shall be considered as fulfilling the requirements for screenings when a minimum percentage of screenings is specified for a particular mixture.

(c) Mineral Filler

Mineral filler shall consist of thoroughly dry stone dust, slate dust, portland cement, fly ash or other mineral dust approved by the Engineer. The mineral filler shall be free from foreign and other injurious matter.

When tested by Test Method Tex-200-F* (Dry Sieve Analysis), it shall meet the following grading requirements:

	<u>Percent by Weight</u>
Passing a No. 30 Sieve	95 to 100
Passing a No. 80 Sieve, not less than	75
Passing a No. 200 Sieve, not less than	55

(2) Asphaltic Material for Porous Asphalt Paving Mixture

Asphalt for the paving mixture shall be asphalt cement, viscosity grade AC-20* and shall meet the requirements of the Item, "Asphalts, Oil and Emulsions." The Contractor shall notify the Engineer of the source of his asphaltic material prior to production of the asphaltic mixture and this source shall not be changed during the course of the project except on written permission of the Engineer.

The paving mixture shall consist of a uniform mixture of coarse aggregate, fine aggregate, asphaltic material and mineral filler, if required.

The grading of each constituent of the mineral aggregate shall be such as to produce, when properly proportioned, a mixture which, when tested in accordance with Test Method Tex-200-F* (Dry Sieve Analysis), will conform to the limitations for master grading given below:

	<u>Percent by Weight</u>
Passing 1/2" Sieve	100
Passing 3/8" Sieve, Retained on No. 4 Sieve	40-65
Passing No. 4 Sieve, Retained on No. 8 Sieve	3-35
Passing No. 8 Sieve, Retained on No. 16 Sieve	1-20
Passing No. 16 Sieve, Retained on No. 200 Sieve	0-10
Passing No. 200 Sieve	2-5

The asphaltic material shall form from 5.5 to 6.0 percent of the mixture by weight unless specified otherwise on the plans.

The Engineer will designate the exact grading of the aggregate and asphalt content, within the above limits, to be used in the mixture. The paving mixture produced should not vary from the designated grading and asphalt content by more than the tolerances allowed herein; however, the mixture produced shall conform to the limitations for master grading specified above.

	<u>Percent by Weight</u>
Passing 1/2" Sieve, Retained on 3/8" Sieve	+ 5
Passing 3/8" Sieve, Retained on No. 4 Sieve	+ 5
Passing No. 4 Sieve, Retained on No. 8 Sieve	+ 5
Total Retained on No. 8 Sieve	+ 5
Passing No. 8 Sieve, Retained on No. 16 Sieve	+ 3
Passing No. 16 Sieve, Retained on No. 200 Sieve	+ 3
Passing No. 200 Sieve	+ 3
Asphalt Material	+ 0.25

Should the paving mixture produced vary from the designated grading and asphalt content by more than the above tolerances, proper changes are to be made until it is within these tolerances.

Samples of the mixture when tested in accordance with Test Method Tex-210-F* shall not vary from the grading proportions of the aggregate and the asphalt content designated by the Engineer by more than the respective tolerances specified above and shall be within the limits specified for master grading.

C.3 EQUIPMENT

(I) Mixing Plants

Mixing plants that will not continuously meet all the requirements of this specification shall be condemned.

Mixing plants may be either the weight-batching type or the continuous mixing type. Both types of plants shall be equipped with satisfactory conveyors, power units, aggregate handling equipment, aggregate screens and bins and shall consist of the following essential pieces of equipment:

(a) Weight-Batching Type

Cold Aggregate Bin and Proportioning Device. The cold aggregate bins or aggregate stockpiles shall be of sufficient number and size to supply the amount of aggregate required to keep the plant in continuous operation. The proportioning device shall be such as will provide a uniform and continuous flow of aggregate in the desired proportion to the plant.

Dryer. The dryer shall be of the type that continually agitates the aggregate during heating and in which the temperature will be so controlled that aggregate will not be injured in the necessary drying and heating operations required to obtain a mixture of the specified temperature.

The burner, or combination of burners, and type of fuel used shall be such that in the process of heating the aggregate to the desired or specified temperatures, no residue from the fuel shall adhere to the heated aggregate.

A recording thermometer shall be provided which will record the temperature of the aggregate when it leaves the dryer. The dryer shall be of sufficient size to keep the plant in continuous operation.

Screenings and Proportioning. The screening capacity and size of the bins shall be sufficient to screen and store the amount of aggregate required to properly operate the plant and keep the plant in continuous operation at full capacity. Proper proportions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where accurate representative samples of aggregate may be taken from the bins for testing. Separation of hot bin into compartments will not be required providing uniform grading and asphalt content are consistently produced in the completed mix.

Aggregate Weigh Box and Batching Scales. The aggregate weigh box and batching scales shall be of sufficient capacity to hold and weigh a complete batch of aggregate. The weigh box and scales shall conform to the requirements of the Item, "Weighing and Measuring Equipment."

Asphaltic Material Bucket and Scales. The asphaltic material bucket and scales shall be of sufficient capacity to hold and weigh the necessary asphaltic material for one batch. If the material is measured by weight, the bucket and scales shall conform to the requirements of the Item, "Weighing and Measuring Equipment."

If a pressure type flow meter is used to measure the asphaltic material, the requirements of the Item, "Weighing and Measuring Equipment" shall apply.

Mixer. The mixer shall be of the pug mill type and shall have a capacity of not less than 20 cubic feet (0.57 m^3) unless otherwise shown on the plans. The number of blades and the position of same shall be such as to give a uniform and complete circulation of the batch in the mixer. The mixer shall be equipped with an approved spray bar that will distribute the asphaltic material quickly and uniformly throughout the mixer. Any mixer that has a tendency to segregate the mineral aggregate or fails to secure a thorough and uniform mixing with the asphaltic material shall not be used. This shall be determined by mixing the standard batch for the required time, then dumping the mixture and taking samples from its different parts. This will be tested by the extraction test and must show that the batch is uniform throughout. All mixers shall be provided with an automatic time lock that will lock the discharge doors of the mixer for the required mixing period. The dump door or doors and the shaft seals of the mixer shall be tight enough to prevent spilling of aggregate or mixture from the pug mill.

(b) Continuous Mixing Type

Cold Aggregate Bin and Proportioning Device. Same as for weight-batching type of plant.

Dryer. Same as for weight-batching type of plant.

Screening and Proportioning. Same as for weight-batching type of plant.

Aggregate Proportioning Device. The hot aggregate proportioning device shall be so designed that when properly operated a uniform and continuous flow of aggregate into the mixer will be maintained.

Asphaltic Material Spray Bar. The asphaltic material spray bar shall be designed such that the asphalt will spray uniformly and continuously into the mixer.

Asphaltic Material Meter. An accurate asphaltic material recording meter shall be placed in the asphalt line leading to the spray bar so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of the meter output. The asphalt meter and line to the meter shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line and meter near the temperature specified for the asphaltic material.

If a pressure type flow meter is used to measure the asphaltic material, the requirements of the Item "Weighing and Measuring Equipment" shall apply.

Mixer. The mixer shall be of the pug mill continuous type and shall have a capacity of not less than 40 tons (36.3 Mg metric ton) of mixture per hour. Any mixer that has a tendency to segregate the aggregate or fails to secure a thorough and uniform mixing of the aggregate with the asphaltic material shall not be used. The dam gate at the discharge end of the pug mixer and/or pitch of the mixing paddles shall be so adjusted as to maintain a level of mixture in the pug mixer between the paddle shaft and the paddle tips (except at the discharge end).

Truck Scales. A set of standard platform truck scales, conforming to the Item, "Weighing and Measuring Equipment," shall be placed at a location approved by the Engineer.

(2) Asphaltic Material Heating Equipment

Asphaltic material heating equipment shall be adequate to heat the amount of asphaltic material required to the desired temperature. Asphaltic material may be heated by steam coils which shall be absolutely tight. Direct fire heating of asphaltic material will be permitted, provided the heater used is manufactured by a reputable concern and there is positive circulation of the asphalt throughout the heater. Agitation with steam or air will not be permitted. The heating apparatus shall be equipped with a recording thermometer with a 24-hour chart that will record the temperature of the asphaltic material at the highest temperature.

(3) Spreading and Finishing Machine

The spreading and finishing machine shall be of a type approved by the Engineer, shall be capable of producing a surface that will meet the requirements of the typical cross-section and a surface test, when required, and when the mixture is dumped directly into the finishing machine shall have adequate power to propel the delivery vehicles in a satisfactory manner. The finishing machine shall be equipped with a flexible spring and/or hydraulic type hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the mixture is being unloaded.

The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel in such a manner as to obtain the desired lines and grades without resorting to hand finishing will not be allowed.

Automatic screed controls, if required, shall meet the requirements of the Item, "Automatic Screed Controls for Asphaltic Concrete Spreading and Finishing Machines."

(4) Pneumatic Tire Rollers

The rollers shall be acceptable light pneumatic tire rollers conforming to the requirements of the Item, "Rolling (Pneumatic Tire)," unless otherwise specified on plans.

The tire pressure of each tire shall be adjusted as directed by the Engineer and this pressure shall not vary by more than 5 pounds per square inch (34.5 kPa, kilo pascal).

(5) Two Axle Tandem Roller

This roller shall be an acceptable power driven tandem roller weighing not less than 6 tons (5.4 Mg), or more than 10 tons (9.1 Mg).

(6) Three Wheel Roller

This roller shall be an acceptable power driven three wheel roller weighing not more than 10 tons (9.1 Mg).

(7) All Equipment shall be maintained in good repair and operating condition and shall be approved by the Engineer.

(8) Alternate Equipment

When permitted by the Engineer, in writing, equipment other than that specified, which will consistently produce satisfactory results, may be used.

C.4 STOCKPILING, STORAGE, PROPORTIONING AND MIXING

(1) Aggregate Storage

If the mineral aggregates are stored or stockpiled, they shall be handled in such a manner as to prevent segregation, mixing of the various materials or sizes, and contamination with foreign materials. The grading of aggregates proposed for use and as supplied to the mixing plant shall be uniform. Suitable equipment of acceptable size shall be furnished by the Contractor to work the stockpiles and prevent segregation of the aggregates.

(2) Storage and Heating of Asphaltic Materials

The asphaltic material storage shall be ample to meet the requirements of the plant. Asphalt shall not be heated to a temperature in excess of that specified in the Item, "Asphalts, Oils and Emulsions." All equipment used in the storage and handling of asphaltic material shall be kept in a clean condition at all times and shall be operated in such a manner that there will be no contamination with foreign matter.

(3) Feeding and Drying of Aggregates

The feeding of various sizes of aggregate to the dryer shall be done through the cold aggregate bin and proportioning device in such a manner that a uniform and constant flow of materials in the required proportions will be maintained. When specified on the plans, the cold aggregate bins

shall be charged by use of a clamshell, dragline, shovel or front end loader. The aggregate shall be dried and heated to the temperature necessary to produce a mixture having the specified temperature.

(4) Proportioning

The proportioning of the various materials entering the asphaltic mixture shall be as directed by the Engineer and in accordance with these specifications. Aggregate shall be proportioned by weight using the weigh box and batching scales herein specified when the weight-batch type of plant is used and by volume using the hot aggregate proportioning device when the continuous mixer type of plant is used. The asphaltic material shall be proportioned by weight or by volume based on weight using the specified equipment.

(5) Mixing

(a) Batch Type Mixer

In the charging of the weigh box and in the charging of the mixer from the weigh box, such methods or devices shall be used as are necessary to secure a uniform asphaltic mixture. In introducing the batch into the mixer, the mineral aggregate shall be introduced first; shall be mixed thoroughly for a period of 5 to 20 seconds, as directed, to uniformly distribute the various sizes throughout the batch before the asphaltic material is added; the asphaltic material shall then be added and the mixing continued for a total mixing period of not less than 30 seconds. This mixing period may be increased if, in the opinion of the Engineer, the mixture is not uniform.

(b) Continuous Type Mixer

The amount of aggregate and asphaltic material entering the mixer and the rate of travel through the mixer shall be so coordinated that a uniform mixture of the specified grading and asphalt content will be produced. Checks on asphalt used shall be made at least twice daily by comparing the asphalt used in ten loads of completed mix as shown on the asphalt recording meter and the design amount for these ten loads. The acceptable percent of variation between the asphalt used and the design amount will be as shown on the plans or as determined by the Engineer.

(c) The Mixture produced from each type of mixer shall not vary from the specified mixture by more than the tolerances herein specified.

- (d) The Surface Mixture from each type of mixer will not exceed a temperature of 260° F (127° C) and shall be specified by the Engineer. The temperature of the mixture will not be lower than 180° F (82° C) when placed on the road.

C.5 CONSTRUCTION METHODS

- (1) The surfacing mixture shall not be placed when the air temperature is below 50° F (10° C) and is falling, but it may be placed when the air temperature is above 40° F (4° C) and rising. The air temperature shall be taken in the shade away from artificial heat. It is further provided that the surfacing mixture shall be placed only when the humidity, general weather conditions and temperature and moisture condition of the pavement surface, in the opinion of the Engineer, are suitable.

- (2) Transporting the Surface Mixture

The mixture, prepared as specified above, shall be hauled to the work in tight vehicles with smooth dump beds that have been previously cleaned of all foreign material. The dispatching of vehicles shall be arranged so that all material delivered may be placed, and all rolling shall be completed during daylight hours. In cool weather or for long hauls, canvas covers and insulating of the truck bodies may be required. The inside of the truck body shall be sprayed with a non-petroleum release agent satisfactory to the Engineer, if necessary, to prevent the mixture from adhering to the body.

- (3) Placing

The asphaltic mixture shall be dumped directly into the specified spreading and finishing machine and spread on the approved prepared surface in such a manner that, when properly compacted, the finished surface will be smooth and of uniform texture and density. The spreading and finishing machine shall be operated at a speed satisfactory to the Engineer. During application of asphaltic material, care shall be taken to prevent splattering of adjacent pavement, curb and gutter and structures.

- (4) Compacting

- (a) As directed by the Engineer, the surface mixture shall be compressed lightly and uniformly with the specified rollers and/or other approved rollers.
- (b) Compaction of the surface course shall be done while the surface is cool enough to resist the roller used. One or two passes by the

roller is all that is required, as excess rolling could cause a reduction in surface course porosity.

- (c) The motion of the rollers shall be slow enough at all times to avoid displacement of the mixture. If any displacement occurs, it shall be corrected at once by the use of rakes and of fresh mixture where required. To prevent adhesion of the surfacing mixture to the roller, the wheels shall be kept thoroughly moistened with a soap-water solution. Necessary precautions shall be taken to prevent the dropping of gasoline, oil, grease or other foreign matter on the pavement, either when the rollers are in operation or when standing.

(5) Surface Tests

The surface of the pavement, after compaction, shall be smooth and true to the established line, grade and cross-section, and when tested with a 10-foot (3.0 m) straight-edge, the maximum deviation shall not exceed ¼ inch (6 mm) in 10 feet (3.0 m), and any point in the surface not meeting this requirement shall be corrected as directed by the Engineer. The completed surface shall meet the approval of the Engineer for riding surface finish and appearance.

- (6) After final rolling, no vehicular traffic of any kind shall be permitted on the porous pavement until cooling or hardening has taken place, as directed by the Engineer, but in no case less than six hours.

C.6 MEASUREMENT

- (1) The surfacing mixture will be measured separately by the ton of 2,000 pounds (907 kilograms, Kg) of "Asphalt" and by the cubic yard of dry, loose "aggregate" of the type actually used in the completed and accepted work in accordance with the plans and specifications for the project. The volume of aggregate in the compacted mix shall be calculated from the measured weights of the surfacing mixture by use of the following formula:

$$V = \frac{(W - A)}{(27)K}$$

V	=	Cubic Yards of aggregate, dry, loose
W	=	Total weight of surfacing mixture in pounds (Kg)
A	=	Weight of Asphalt in pounds (Kg)
K	=	Unit Weight of Aggregate in pounds per cubic foot (Kg/m ³)

The value "K" shall be the average of two or more tests determined by the Engineer in the following manner:

At the beginning of plant operations, a specified weight of dried mineral aggregate shall be placed in an acceptable container that will contain a minimum volume of three cubic yards (2.3 m^3). The aggregate shall be leveled or "struck-off" and measured, to determine the volume of the mineral aggregate, in cubic feet (m^3). The unit weight of the mineral aggregate shall be obtained by dividing the specified weight of dried aggregate in pounds (Kg) by the measured volume in cubic feet (m^3). The value "K" is an average of two or more of the above-described tests.

The value "K" shall be checked a minimum of one time for each 3,000 cubic yards ($2,294 \text{ m}^3$) of mineral aggregate. If, in the opinion of the Engineer or the Contractor's representative, the value of "K" has changed, a check test shall be made. A new value for "K" shall be determined if the checked value of "K" varies more than two percent (plus or minus) from the value being used.

The weight, "W," if mixing is done by a continuous mixer, will be determined by truck scales. The weight, if batched, will be determined on batch scales and records of the number of batches, batch designs and weight of "Asphalt" and "Aggregate" shall be kept.

C.7 PAYMENT

- (1) The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement," will be paid for at the unit prices bid for "Asphalt" and "Aggregate," of the types specified, which prices shall each be full compensation for quarrying, furnishing all materials and freight involved; for all heating, mixing, hauling, cleaning the existing pavement, placing asphalt-aggregate surfacing mixture, rolling and finishing; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.
- (2) All templates, straight-edges, scales and other weighing and measuring devices necessary for the proper construction, measuring and checking of the work shall be furnished, operated and maintained by the Contractor at his expense.

* This item must be verified for local requirements and site conditions.

APPENDIX B

HYDROLOGIC SOIL GROUP CLASSIFICATION

Aastad	B	Albia	C	Amrillo	B	Arveson	D	Baker	C	Bear Lake	D	Bernardston	C	Blanket	B
Aberdeen	D	Albion	B	Amboy	B	Arzeli	D	Balch	A	Beary Prairie	B	Berlen	B	Blanton	A
Abilene	C	Alcester	B	Amelia	C	Asa	B	Baldock	B	Beatty	B	Berthoud	B	Blencoe	C
Abington	B	Alcoa	B	Amelia	B	Asbury	B	Baldwin	C	Beaucoup	C	Bertie	C	Blichton	C
Acadia	D	Alden	D	America	A	Ascalon	B	Balfour	B	Beauford	D	Bertolotti	A	Blockton	C
Acme	B	Alderswood	B	Ames	C	Ashe	C	Balm	A	Beaumont	D	Bertrand	B	Blodgett	B
Acton	B	Aldino	D	Amite	B	Ashum	C	Balmorea	D	Beauregard	C	Berwyn	C	Blomford	B
Adair	D	Alexandria	B	Anity	C	Ashley	A	Bangor	B	Beaver	B	Bethany	C	Bloomfield	A
Adams	A	Alford	B	Ansterdam	B	Ash Springs	A	Banks	A	Beaverhead	B	Bethel	C	Bloomington	B
Adamsville	C	Algarrobo	D	Andrew	D	Ashton	B	Barnerville	C	Becket	C	Beulah	B	Blount	C
Adel	A	Algiers	D	Andres	B	Ashten	B	Barnville	C	Beckton	D	Beverly	A	Blue Earth	D
Adelanto	B	Allice	B	Angie	C	Ashuelot	C	Baraboo	B	Beckwith	D	Bewleyville	B	Bluffton	D
Adelphia	B	Allard	B	Angola	C	Ashwood	D	Barbour	B	Bedford	C	Bibb	D	Bluffton	D
Adler	C	Allegany	B	Ankeny	A	Asotin	B	Barclay	C	Bedford	C	Bickleton	B	Bobtail	C
Adolph	D	Allen	B	Ankendale	B	Assumption	B	Barnard	C	Bedington	B	Biddleford	D	Bodine	B
Afton	D	Allen	C	Anoka	A	Astoria	B	Barnes	B	Beecher	C	Bienville	B	Bogota	C
Agar	B	Allendale	C	Anselmo	B	Athelwood	B	Barnett	D	Beechy	D	Biggs	A	Bohemian	B
Agate	C	Allerton	D	Anthony	G	Atherton	B	Barnett	D	Belfast	D	Biggs	A	Bold	B
Agawam	B	Alligator	D	Antigo	B	Atherton	B	Barney	A	Belfore	C	Biggs	A	Bolivia	B
Agency	C	Allison	C	Apache	B	Athol	B	Barnhardt	A	Belgrade	B	Big Horn	C	Bolton	B
Agnew	B	Allouez	B	Apakule	B	Atkins	D	Barnstead	B	Belknap	C	Billings	D	Bombay	C
Aguadilla	A	Alma	C	Apishapa	C	Atterberry	B	Barrances	D	Belle	R	Binnsville	C	Bonaccord	D
Aguililla	C	Almena	C	Apison	C	Atwood	B	Barron	C	Bellingham	D	Bippus	B	Bonaparte	A
Aguirre	D	Almirante	D	Appling	C	Auburn	C	Barronett	C	Belmont	B	Birds	C	Bonham	B
Ahneek	B	Almo	D	Arch	B	Auburndale	D	Barth	B	Beltrami	B	Birdsall	D	Bonilla	B
Ahnberg	C	Almy	G	Arch	B	Au Gres	C	Bartle	D	Beltsville	C	Birdsboro	B	Bonita	D
Ahtanum	C	Alonso	C	Archer	C	Augusta	C	Basher	B	Belvoir	C	Birkbeck	B	Bonner	B
Aiken	B	Alps	C	Arenzville	B	Aurora	C	Bass	B	Benevola	B	Biscay	D	Bonneville	A
Ailmont	B	Aisen	C	Argyle	B	Austin	B	Bastrop	B	Benfield	C	Blatteroot	C	Bonnie	D
Akaka	B	Altamaha	D	Ark	C	Ava	C	Batavia	B	Benid	D	Blacklock	D	Bono	D
Akan	C	Altamont	C	Arkport	B	Avalanche	B	Bates	B	Bennington	C	Blackwater	D	Bonpas	B
Akeska	B	Altavista	B	Armagh	D	Avery	B	Bath	C	Benolt	D	Bladen	D	Boomer	C
Alachua	B	Alto	C	Armer	C	Avon	B	Baudette	B	Benson	C	Blago	D	Boone	A
Alaola	B	Alton	B	Armour	B	Avonburg	D	Baugh	C	Bentonville	C	Blain	D	Bordeaux	B
Alama	C	Altoona	C	Arnuce	C	Axtell	D	Baxter	B	Beotia	B	Blair	C	Bosket	B
Alamance	C	Altura	B	Arnuchee	C	Ayr	B	Bayamon	B	Berg	C	Blairton	C	Boswell	D
Alamasa	D	Altvan	B	Arnold	A	Babylon	A	Bayard	A	Bergland	D	Blakeland	A	Bow	D
Albation	D	Alvin	B	Arnot	C	Baca	B	Bayboro	D	Berkeley	C	Blakely	B	Bowdoin	D
Albemarle	B	Alvira	C	Arredondo	A	Bagnell	D	Bayside	C	Berks	C	Blanchard	A	Bowdre	C
Albertville	C	Analu	D	Artesia	C	Bainville	B	Beadle	C	Berkshire	B	Blanco	B	Bowie	B
				Arveda	D			Bearden	C	Burmudian	B	Bland	C	Bowmansville	D
								Beardstown	C	Bernard	D	Blandford	C		

80

Fannin B	Grafeld D	Glenville C	Greybull C	Hammerly C	Hayesville B	Highfield B
Fargo D	Garner D	Gloucester B	Greys B	Hamilton B	Haymond B	Higley B
Farland B	Garrison A	Godwin B	Griffin C	Hamlin B	Hayne B	Hiko Springs D
2 Farmington C	Garvin D	Goessel D	Grimstad C	Hammond D	Hayter B	Hilger B
Farnum C	Gasconade D	Gogebic B	Groclosse C	Hamshire C	Hazel C	Hilliard B
Farragut C	Gaslova A	Goldridge A	Groton A	Hampton B	Hazen B	Hillsboro B
Faunce A	Gayville D	Goldston B	Grove A	Hanalei C	Heath B	Hillsdale B
Fauquier B	Gearhart A	Goldston C	Groveland B	Hanceville B	Hebo D	Hilo B
Fawcett C	Geary B	Goldvein C	Grover B	Hand B	Hecia B	Hilton C
Faxon D	Geer C	Goliad C	Groveton B	Hanford B	Hector B	Hinckley A
Fayette B	Geiger D	Gooch C	Grundy C	Hanpoee B	Hedville C	Hinman D
Fe D	Gem C	Gore D	Guadalupe B	Hannagatchee B	Heisler B	Hinwassee B
Felda B	Genesee B	Gorus B	Guanica D	Hanover B	Heitt C	Hiwood A
Fellida B	Genoa B	Goshen B	Guayabo C	Hanska C	Helena C	Hixton B
Fellowship C	Genola B	Gosport C	Guayama C	Hanson B	Hemmi C	Hobble B
Fergus C	Georgetown C	Gothart D	Guckeen C	Harbin B	Hempstead B	Hobbs B
Flander C	Georgeville B	Gowen C	Gudrid B	Harborton C	Henderson D	Hockley C
Fidalgo C	Gerald D	Grady D	Guelph B	Harlem B	Hennepin B	Hoffman C
Fillmore D	Germania B	Graham C	Guernsey C	Harley C	Henry D	Hogansburg B
Fincastle C	Geronimo B	Graff C	Guin A	Harlingen D	Henshaw C	Hoko C
Fitch A	Gila B	Grant B	Guthrie D	Harmony C	Herbert B	Holbrook D
Fitchville C	Gilcrest B	Grande Ronde C	Habersham B	Harpster B	Herkimer B	Holcomb D
Fitzhugh B	Gilead C	Grant B	Hacke D	Harriet D	Hermiston B	Holdrege B
Flamingo D	Giles A	Grantsburg C	Hackers B	Harris D	Hermitege B	Holland B
Flanagan B	Gilford D	Grantsdale B	Hacketts B	Harrisburg C	Hernon B	Hollinger C
Flandreau B	Gilligan B	Granville B	Hacketts B	Harrison C	Hermosa C	Hollister C
Flasher A	Gilean B	Grayling A	Hadley B	Hartline A	Hernando B	Holloway B
Flathead B	Gilpin C	Great Bend B	Hagener A	Hartford B	Herrick C	Holly C
Fleetwood B	Gilson B	Greeley B	Hagerstons B	Hartland B	Herrick C	Hollywood D
Fletcher C	Gilt Edge D	Green Bluff B	Haig C	Hartleton B	Herschel B	Holmdel B
Flint C	Ginat D	Greenbush B	Haidu C	Hartsburg B	Hesch B	Holston B
Flora D	Gird B	Greendale B	Haines B	Hartsells B	Hesseltine A	Holt B
Florence C	Givin C	Greenfield B	Halawa C	Hartwood B	Hesson C	2 Holyoke C
Florsheim D	Glasgow C	Greenport C	Haleakala A	Haskill A	Hialeah D	Homer C
Floyd B	Glenbar C	Green River B	Halewood B	Hassel D	Hialeah D	Hondo C
Fluvanna C	Glenbar C	Greensboro B	Half Moon C	Hastings C	Hibbard C	Honeoye B
Foard D	Glencoe D	Greenville B	Halfway C	Hatchie C	Hibbing B	Honokaa B
Foley C	Glenclive A	Greenwater A	Hall C	Hatchie C	Hickory C	Honolua B
Folsom C	Glenclive A	Greer C	Hallmaile B	Havre B	Hicks B	Homomau C
Fonda D	Glenclive A	Grenada C	Hall B	Haxton A	Hidalgo B	Honouliuli C
Fordney A	Glenclive A	Grenville B	Halsey D	Hayden B	Hildwood C	Hood B
Fordville B	Glenclive A	Gresham C	Hamburg B			

Hoodport	A	Huntington	B	Ivanhoe	D	Kanapaha	B	Keyport	C	Kresson	C	Lanark	B	Lawton	B
Hooder	B	Huntsville	B	Ives	B	Kaneoe	B	Keystone	A	Krum	C	Lancaster	B	Lax	C
Hooic	B	Hurley	D	Izagora	C	Kepapala	B	Kibble	C	Kukatau	B	Land	C	Lea	B
Hopewell	C	Hurst	D	Jacana	C	Karnak	B	Kickerville	B	Kunia	B	Landes	B	Leadvale	C
Hopper	B	Hutchinson	C	Jacob	B	Karnes	B	Kelauea	B	Kutztown	C	Landisburg	C	Leaf	D
Houliam	B	Hyattsville	B	Jackson	B	Karro	B	Kelbourne	A	La Belle	C	Lane	C	Leal	B
Hord	B	Hyde	C	Jaffrey	A	Kars	B	Kimbrough	D	La Bette	C	Langford	C	Leavenworth	A
Hornell	C	Hymon	C	Jaucas	A	Kesota	C	Kinghurst	B	Labette	C	Langley	B	Leavitt	B
Horton	B	Iao	B	Jayuya	C	Kasson	C	Kings	C	Labounty	C	Langrell	B	Leavittville	B
Hosmer	C	Iberia	D	Jeannerette	C	Katemy	D	Kipling	D	La Brier	C	Lanham	D	Lebanon	D
Houdeck	B	Ida	B	Jefferson	B	Kato	B	Kipp	B	Lacamas	D	Lansdale	B	Labar	B
Houghton	C	Idana	C	Jerauld	D	Katy	D	Kipson	D	La Casa	C	Landsdowne	C	Leck Kill	B
Houlton	C	Ihlen	D	Jerome	D	Kaufman	D	Kirkland	D	Lackawanna	B	Lansing	B	Lee	D
Housatonic	C	Illion	C	Jessup	C	Kawaihae	C	Kirvin	C	Ladd	C	Lantz	D	Leeds	B
Houston	C	Illipollis	B	Joe Creek	B	Kawaihapal	A	Kistler	B	Ladoga	D	La Palma	B	Leeper	D
Houston Black	D	Imperial	D	Johnston	D	Kealakakua	B	Kittas	B	La Grande	C	Lapine	A	Leetonia	B
Hoyden	B	Immodalee	C	Joliet	C	Keansburg	D	Kittas	B	La Houge	B	Laporte	D	Legore	C
Hoyne	D	Ina	C	Joplin	B	Keating	C	Kittas	B	La Houghton	D	La Prairie	B	Legh	C
Howard	B	Independence	A	Josefa	D	Keene	C	Kiwanis	B	Laidig	C	Laredo	B	Leila	D
Howell	B	Ingfield	C	Joy	B	Kelth	B	Klaberg	C	Laidlaw	A	Lares	C	Lempster	D
Hoye	C	Inman	C	Juana Diaz	B	Kelly	B	Klamath	C	Lale	D	Largent	C	Lena	D
Hoyleton	C	Inota	D	Judith	B	Kelso	C	Klaus	A	Lairdsville	B	Largo	C	Lenoir Fine	
Hoypus	A	Iola	B	Judson	B	Kelton	A	Klej	B	Lajas	C	Larimer	C	Sandy	B
Hoyville	D	Iola	A	Jules	B	Kemperville	B	Kline	A	Lake Charles	D	Larkin	C	Lenoir	
Hubbard	A	Iona	B	Juliaetta	A	Kempton	B	Knappa	B	Lake Creek	B	Larry	D	Lenox	C
Huckabee	A	Ipava	B	Juncos	C	Kenansville	B	Knight	C	Lakehurst	A	Las Animas	A	Leon	C
Huckleberry	C	Iredell	D	Junlata	B	Kendaia	C	Knox	B	Lakeland	A	Lashley	B	Leona	D
Hudson	C	Irion	D	Junius	C	Kendall	B	Koch	C	Lakemont	C	Las Lucas	D	Leonardtown	D
Huey	D	Irish	D	Juno	A	Kennebec	B	Koehler	B	Lakeville		Las Piedras	D	Leota	C
Huff	B	Iron River	B	Kaena	D	Kennedy	B	Kohala	B	Lakeville		Lassen	C	Leshara	B
Huffine	B	Irurena	D	Kahana	B	Kenney	A	Kokokahi	D	Loam	B	Las Vegas	D	Lester	B
Huggins	C	Irvington	C	Kalamazoo	B	Kenspur	B	Kikomo	D	Lakewood	A	Latah	C	LeSueur	B
Hugo	B	Irwin	D	Kallispell	B	Kent	D	Kolekole	C	Lakin	A	Lauderdale	C	Letcher	C
Humacoo	C	Isanti	D	Kalispell	B	Keomah	C	Konokti	A	La Lande	B	Laurel	B	Letort	D
Humbarger	B	Isote	B	Kalkaska	B	Kerby	B	Koolau	D	Lamington	D	Lauren	A	Levan	A
Humeson	C	Isom	B	Kermishaw	A	Kerri	C	Kipiah	D	Lamont Fine		Laveen	B	Lewisberry	B
Humphreys	B	Issaquah	B	Kettle	B	Kerrtown	B	Kismos	D	Sandy Loam	A	La Verkin	B	Lewisston	C
Hunt	D	Istokpoga	D	Kettie	B	Kershaw	A	Koster	C	Lamont Loam	B	Lawnhorn	D	Lewisville	B
Hunters	B	Iuka	C	Kettie	B	Kettie	B	Kranzburg	B	Lamonta	C	Lawrence	C	Lexington	B
				Kettie	B	Kettie	B	Krause	B	Lamoure	C	Lawrenceville	C	Liberty	C
				Keysport	C	Keysport	C	Kreamer	C	Lamson	C	Lawson	B	Lick	B

Lick Creek	B	Lonepine	B	Lynden	A	Mansfield	D	Maunee	D	Melvin	D	Miniqua	B	Horse	D
Lickdale	D	Lone Rock	B	Lyndyl	C	Mansic	C	Maunabo	D	Memphis	B	Minora	C	Horton	B
Lightning	D	Longford	C	Lystsair	D	Mansker	B	Maury	B	Menahga	A	Minvale	B	Hoscow	B
Lignum	C	Longlis	C			Mantachle	C	Maverick	D	Mench	B	Mires	A	Hoshannon	B
Likes	A	Loneke	B	Mabi	D	Manteco	D	May	B	Menfro	B	Mission	C	Mossyrock	A
Lima	C	Loodout	C	Machete	C	Manvel	B	Mayhew	D	Menlo	D	Mitchell	B	Hottsville	A
Limerick	C	Loon	A	Hack	B	Maple	D	Maynard Lake	B	Mentor	B	Moca	D	Mount Carroll	B
Lincroft	A	Lordale	B	Macomber	C	Mapleton	C	Mayo	B	Mercedita	D	Mocle	C	Mount Lucas	C
Lincoln	A	Lorain	C	Macon	C	Marble	C	Mayodan	B	Mercer	C	Moendipie	C	Mountview	B
Lincroft	C	Lordstown	C	Madalin	C	Marcus	D	Maytown	C	Mereta	C	Moffat	B	Mucara	B
Lindley	C	Lorella	C	Madlock	A	Marcy	D	Mazepa	B	Meridian	B	Mohave	B	Muir	B
Lindsborg	D	Lorenzo	A	Madrox	A	Mardin	C	McAfee	B	Meros	A	Mohawk	B	Muirkirk	B
Lindside	C	Loring	B	Madison	B	Marengo	D	McAllister	C	Merrimac	B	Mohawk	B	Mukilleo	A
Lindstrom	C	Los Guineos	D	Madras	C	Mariana	C	McBride	B	Mertz	B	Molese	C	Mullins	D
Linganore	C	Los Osos	C	Madrid	B	Marias	D	McDonald	C	Mesa	B	Modena	C	Munishing	B
Link	B	Louden	C	Maginnis	C	Marietta	B	McDowell	D	Meskill	D	Molena	A	Munuscong	D
Linker	B	Loudonville	C	Magnolia	B	Marina	A	McEwen	C	Metea	B	Moline	D	Murilli	B
Linneus	B	Louisa	B	Mahaska	B	Marion	D	McGary	C	Methow	B	Monarda	C	Muscatine	B
Lino	C	Louisburg	C	Mahomen	B	Marissa	C	McKamie	C	Metollus	A	Monnee	D	Muse	B
Lintonia	B	Loup	D	Mahoning	D	Markland	C	McKay	D	Mexico	D	Monmouth	C	Muskingum	C
Lisbon	B	Lowell	C	Malden	C	Marksboro	B	McKenna	B	Mhoon	C	Monona	B	Muskogee	C
Lismas	D	Loy	D	Malle	B	Mariboro	B	Mckenzie	D	Halmi	B	Monongahela	C	Musselshell	B
Lismore	B	Loysville	C	Makalapa	D	Marlow	C	McLain	C	Middlebury	B	Monroeville	C	Myatt	D
Littlefield	D	Lualuie	D	Makawao	B	Marlton	C	McMurray	A	Midland	D	Montalto	B	Myersville	B
Little Horn	B	Lucas	C	Makena	B	Marlton	C	McNeal	C	Midway	D	Montara	D		
Littleton	B	Lucas	C	Malaga	D	Marquette	B	McPaul	B	Miffilnurg	B	Monteola	D		
Litz	C	Lucien	C	Malaya	C	Marshall	B	McPherson	D	Miguel	D	Montesano	B	Naaiehu	B
Livingston	D	Lucien	C	Maleza	B	Martha	C	Meadin	A	Millac	B	Montevallio	C	Naches	B
Llave	C	Lufkin	C	Mamala	C	Martin Pena	D	Measowville	B	Millam	B	Montevallio	C	Nacimlento	C
Lloyd	B	Lumli	C	Manalapan	D	Martinsdale	B	Headville	B	Miles	B	Montgomery	D	Nacogdoches	C
Lobel	B	Lun	C	Manana	C	Martinton	C	Mecklenburg	C	Millford	C	Monticello	B	Naiwa	B
Lobelville	C	Lunt	C	Manassa	B	Masada	B	Meda	B	Millbrook	B	Montoya	D	Nakelele	B
Lockhard	B	Lupton	C	Manassas	B	Mason	B	Medary	C	Mill Creek	B	Moody	B	Natucket	C
Lockport	C	Lura	D	Manatash	C	Massena	C	Medford	C	Miller	D	Moreau	D	Nanum	B
Locust	C	Luray	C	Manatee	D	Massillon	B	Medina	B	Millington	B	Morley	C	Napa	D
Lodi	B	Luton	D	Manchester	A	Matanzas	C	Medio	C	Millsdale	B	Mormon Mesa	D	Napier	B
Logan	C	Luverne	B	Manhus	C	Matapeake	B	Meeteetse	C	Milo	D	More Bay	D	Nappanee	D
Logandale	C	Lyman	C	Manhattan	B	Matawan	C	Mehlhorn	C	Mimosa	C	Moro Cojo	A	Narajito	C
Lolo	B	Lynchburg	C	Manheim	C	Matlock	D	Meigs	C	Mimosa	C	Morro	C	Narcliffe	B
Lomax	B			Manlius	C	Matmon	C	Meibourne	C	Minatare	D	Morrill	B	Narragansett	C
				Manor	B	Matney	B	Meilenthin	B	Minore	B	Morris	C	Nasel	C
								Meirose	C	Mineola	B	Morris	C	Nason	C
								Melvorn	C	Miner	D	Morrow	C	2 Nassua	C
														Natalie	C

Natchez B	Nixon B	Odin C	Orio C	Palatine C	Pedernales C	Pinones D	Pottsville D
Natchitoches D	Nixonton B	O'Fallon C	Orion C	Palatine B	Perkin C	Pinson B	Poultney B
National A	Noble B	Ogenaw B	Orlando C	Palmas Altas D	Perkin B	Pintura A	Poverty C
Navajo D	Nobscot A	Okaw D	Orlando High Phase	Palm Beach A	Pella B	Pisgah B	Powder B
Navasota D	Nodaway B	Okeechobee D	Orlando Low Phase	Palm Dale C	Pembroke B	Pittsfield C	Powell C
Navasink B	Nogates C	Okeelanta D	Orman D	Plamira B	Pence B	Pittstown C	Poygan D
Naylor C	Nohili D	Okenah C	Orrville C	Palouse B	Penn C	Pittwood B	Pozo Blanco C
Nebish B	Nolan C	Okoboji B	Ortello A	Pana B	Pennington B	Placencia D	Prather C
Nebie A	Nolichuncky B	Oktibbeah D	Ostello C	Pandura B	Penoyer C	Plainfield A	Pratt A
Needmore C	Nolo C	Olaa B	Osting C	Panton D	Penrose C	Plano B	Prentiss C
Negley B	Nonopahu C	Olequa C	Osage D	Papage B	Penwood A	Plata C	Prescott D
Nehalem B	Nookachamps D	Olinde B	Oseola D	Papakating D	Peoh C	Platea C	Presque Isle B
Nellis B	Nooksack C	Oliver C	Oshawa D	Papago B	Penone C	Platner C	Preston A
Neosho D	Nora B	Olmitz B	Oshemo B	Papating D	Peotone C	Plattsmouth B	Prewitt C
Neptune A	Norden B	Olmsted C	Osmund B	Papineau C	Pequea C	Plattville B	Prieta B
Nereson B	Norfolk B	Olympic B	Oso A	Parishville C	Perkinsville B	Pledger D	Princeton B
Neshaminy B	Norge C	Omaha B	Ostrander B	Parkdale A	Perks A	Plummer D	Pring B
Nesika B	Norma C	Omega A	Otero B	Park B	Perrine D	Plymouth B	Proctor B
Nestor D	Northport C	Ona C	Othello D	Parker B	Perry D	Pocomoke D	Progresso B
Neubert B	North Powder C	Onalaska B	Otisville A	Parkwood C	Persayo D	Podunk B	Promise D
Nevada D	Northumberland C	Onamia B	Osego C	Parness D	Pershing C	Poinsett B	Prospect B
Neville B	Northville D	Onarga B	Otawa A	Parr B	Peru C	Poland B	Prosser B
Newark C	Norton D	Onaway B	Otter D	Parsons D	Peshastin A	Polson C	Providence C
Newart B	Norwich D	Ondawa B	Otterholt B	Pasco B	Petoskey A	Pomello A	Provo B
Newberg B	Nowood B	Oneida C	Ottokee A	Paso Seco C	Petrolia D	Pompano D	Powers B
Newberry C	Nosbig D	O'Neil B	Otway D	Pasquotank D	Pettis B	Pomroy B	Ptarmigan B
New Cambria C	Noby C	Onslow B	Ovid C	Patent C	Pheba C	Poncena D	Puget B
New Fane B	Nuckolls C	Ontario B	Owaneco D	Patit Creek B	Phelps B	Pond Creek C	Puhl B
Newkirk B	Nueces A	Ontoneagon C	Owen Creek C	Patoutville C	Phillips D	Pontotoc B	Pulaski B
Newport B	Nunda C	Onyx B	Owens D	Partick B	Philo C	Pope B	Pulehu A
Newton D	Nunn C	Ookala B	Ozona C	Pattin C	Picacho D	Poppleton A	Pulman D
Newtonia B	Nutley D	Oquaga C	Paaloo B	Paulding D	Pickaway C	Poquonock C	Purdy d
Nicholson B	Nymore A	Oquawka A	Pasahua B	Pawela C	Pickford D	Port B	Purgatory D
Nicholville B	Oahe B	Ora C	Pace B	Pawlet B	Pickwick B	Portales B	Puu Oo B
Nickle D	Oakford B	Oracle B	Paden C	Pawnee D	Pierce B	Port Byron B	Puu Pa B
Nicollet B	Oakland B	Orange D	Page D	Paxton C	Pierre D	Porters B	Puyallup B
Niles C	Oasis C	Orangeburg B	Pahrnagat C	Paymaster B	Pilchuck A	Portland D	Quamba D
Nimrod C	Oasis A	Orcas A	Pahrnagat C	Payne D	Pilot B	Portsmouth D	Quandahli B
Ninigret B	Ochlocknee B	Orchard B	Pahroc D	Peace River D	Pilot B	Portugues D	Quay C
Niota D	Ochopee D	Orday D	Pala B	Peacham D	Pilot Rock C	Poskin C	Quincy C
Nipe B	Ockley B	Orella D	Painesville B	Pearman C	Pima C	Post D	Quicksell C
Nisqually A	Oconee C	Orella D	Paiso C	Pearson C	Pinal D	Potamo D	Quincy A
Nixa C	Odessa C	Orient B	Palute B	Pecatonica B	Pinckney C	Potter C	Quinian B

Quonset	A	Regent	C	Riverton	C	Rox	B	Salkum	D	Scipio	D	Shoals	C	Solomon	
Reber	C	Regnier	D	Roane	C	Roy	B	Salmon	B	Scituate	C	Shook	B	Somers	B
Rabin	B	Reinach	B	Roanoke	D	Royalton	C	Salol	D	Scobey	B	Shoshone	B	Somerset	B
Racine	B	Reliance	C	Robbs	D	Roza	D	Salttillo	C	Scott	D	Shouns	B	Sonoita	B
Racoon	D	Renfrow	D	Robertsville	D	Rozetta	B	Saluvia	C	Scott Lake	B	Shrewsbury	D	Sontag	D
Radford	D	Reno	D	Robinsonville	B	Ruark	C	Salvisa	D	Scotville	C	Shubuta	C	Sova	D
Radnor	B	Renovill	C	Roby	C	Rubicon	A	Semish	D	Scranton	C	Shuah	C	Sparta	A
Ragnor	A	Renova	B	Rockaway	B	Rubio	C	Semamish	B	Searing	B	Sidly	B	Spearfish	B
Ragnar	A	Renshaw	B	Rockbridge	B	Rucker	B	Sams	B	Seaton	B	Sidell	B	Spencer	B
Rago	C	Renslow	B	Rockdale	D	Rudyard	C	San Antonio	C	Sebaka	D	Sierra	C	Sperry	C
Rainbow	C	Rentide	C	Rockmart	C	Ruford	B	San Jose	B	Sebewa	D	Sifton	B	Spilo	D
Rains	D	Reparada	D	Rockport	B	Rumney	C	San German	C	Sebring	D	Signal	C	Spooner	C
Ralston	B	Retsof	C	Rockton	B	Rupert	A	Sango	C	Sedan	C	Siler	A	Spottswood	B
Ramona	C	Rex	C	Rockwood	B	Rushtown	A	San Joaquin	D	Segal	D	Silerton	B	Spring	D
Ramsey	B	Reynolds	B	Rocky Ford	B	Rushville	D	San Jose	B	Segno	B	Silver Creek	D	Spring Creek	D
Randall	D	Rhinebeck	C	Rodman	A	Ruskin	C	San Juan	B	Sediu	C	Simcoe	B	Springer	A
Ranger	C	Rhodes	D	Roe	B	Russell	B	San Saba	D	Sleah	C	Sinclair	B	Springfield	D
Rankin	C	Richfield	B	Roebuck	D	Russellville	C	Santa Clara	D	Selkirk	D	Sinclair	B	Springtown	B
Rantoul	D	Richland	C	Rogers	D	Ruston	B	Santa Clara	D	Selle	A	Sinal	C	Spur	B
Rapidan	C	Richview	C	Rohrersville	D	Rutledge	D	Santa Isabel	D	Selma	B	Sinclair	B	Staatsburg	C
Rarden	C	Richwood	B	Rokeby	D	Ryder	C	Santa Lucia	C	Semahmoo	B	Singsaas	B	Stambaugh	B
Raritan	B	Ridgebury	C	Rolf	C			Santiago	B	Senecaville	C	Sioux	B	Stamford	D
Raub	B	Ridgely	B	Romeo	C	Subana	C	Sargeant	D	Sequatchie	B	Sipple	B	Stanfield	C
Rauville	D	Ridgeville	B	Romulus	D	Subana Seca	D	Sarpy	A	Sequoia	C	Siskiyou	B	Stanton	D
Ravalli	D	Riesel	D	Rosachi	D	Saco	D	Sassafras	B	Serrano	D	Sites	C	Starr	B
Ravenna	C	Riffe	A	Rosario	C	Saffell	B	Sauble	A	Sexton	D	Skaggs	C	Staser	B
Ravola	B	Riga	C	Roscoe	C	Sage	D	Saugatuck	C	Seymore	C	Skagit	B	State	B
Ray	B	Riggs	D	Rosebud	B	Sagemoor	C	Sauk	B	Shannon	B	Skalkaho	B	Stecum	D
Rayne	B	Riley	B	Rosebush	B	St. Albans	B	Savage	C	Shapleigh	C	Skamania	B	Steakee	C
Redington	C	Rilito	B	Rosedell	D	St. Charles	B	Savannah	C	Sharkey	D	Skames	C	Steinauer	B
Reagan	C	Rimer	C	Roselms	D	St. Clair	D	Sawmill	C	Sharon	B	Skerry	C	Stensburg	B
Reaton	B	Rinard	D	Rosemount	B	St. Helens	A	Sawtooth	C	Sharpburg	B	Skiyou	B	Stendal	C
Reaville	C	Ringling	C	Roseville	B	St. Joe	B	Sawyer	C	Shavano	B	Skokomish	A	Stephensburg	B
Rebeck	C	Ringold	B	Rositas	A	St. Johns	D	Saybrook	B	Shelburne	C	Skyberg	C	Standahl	C
Red Bay	B	Rio Arriba	D	Roslyn	C	St. Lucie	A	Scantic	C	Shelby	C	Skykomish	B	Stephensburg	C
Redfield	B	Rio Canas	C	Ross	B	St. Marys	C	Scarboro	D	Shelbyville	C	Sleeth	C	Stephensville	B
Red Hook	C	Rio Lajas	A	Rossmoyne	C	St. Paul	C	Schapville	C	Shelmadine	C	Sloan	D	Stetson	B
Relands	B	Rio Pledras	D	Round Butte	D	Salal	B	Schoharie	C	Shelocta	B	Sloan	C	Stevenson	B
Redmond	B	Ritchey	B	Routon	D	Salem	B	Schooley	D	Shelton	B	Snow	B	Stewart	D
Reed	D	Rittman	C	Rowe	D	Salemsbury	B	Schooler	C	Sheppard	A	Soda Lake	B	Stidham	B
Reeser	C	Ritzville	B	Rowland	C	Salisbury	D	Schuykill	B	Sheridan	B	Sodua	C	Stimson	B
Reeves	C	Riverside	A	Rowley	C	Salix	B	Scho	B	Sherman	B	Soller	D	Stissing	C
								Scotenville	C	Shiloh	C				

Stockbridge C	Tenino A	Tisch C	Tromp B	Ulysses B	Verhalen D	Waidupa B
Stockland B	Tepee D	Titusville C	Trout River A	Umapine B	Vernon D	Wailea B
Stockton B	Teresa D	Tivoli A	Trowbridge B	Una D	Verona B	Waimanalo D
Stoneham B	Terril B	Toa C	Troxel B	Unadilla B	Veyo D	Waima B
Stonington B	Terry B	Tobin B	Troy C	Uncomphgre B	Via C	Waipahu C
Stono C	Tescott B	Tobosa D	Truman B	Ungers B	Vicksburg B	Waiska B
Stokey B	Teton B	Todd B	Trumbull D	Union C	Victor B	Waits B
Storden B	Tetanka C	Toddville B	Tubac D	Union B	Victoria D	Wakeland B
Story C	Thackery B	Tokul A	Tucker D	Unity A	Vienna B	Wakonda C
Stough C	Thatuna C	Toledo D	Tucumcari B	Upshur C	Vilas A	Wallace B
Stoy D	Thayer B	Tooley B	Tuffit B	Urbana B	Vinton A	Walla Walla B
Strasburg C	Thomash B	Tolo B	Tujunga A	Usine D	Viola D	Waller C
Strauss C	Thompson A	Tolet B	Tuller D	Ursula D	Vira B	Wallington C
Strawn B	Thornike C	Tombigbee A	Tully C	Utica B	Virgil C	Walldill C
Stronghurst B	Thornton D	Tonawanda C	Tumacacori B	Utah B	Virgin River D	Wallpack B
Stryker D	Thornwood A	Tongue River C	Tumbez D	Utah B	Virgin River D	Walpole C
Stukel C	Thoroughfare A	Tonopah B	Tunwater A	Uvalde B	Virtue C	Walsh B
Stump D	Thorp C	Toppenish C	Tunica D	Vader B	Vista B	Walters D
Sudbury B	Thurman A	Topton B	Tunhannock B	Vader B	Vives C	Walton C
Suffield C	Thurmont B	Torres C	Tupelo D	Vaiden D	Vivl B	Wampsville B
Sula B	Thurston B	Tortugas D	Turberville C	Vale B	Vlasaty C	Wann A
Sulphura C	Tiburones D	Tours C	Turbotville C	Valentine A	Volga D	Wapato C
Sultan B	Tice C	Toutle A	Turin C	Valera C	Volin B	Wapping B
Sumas C	Thickfaw D	Tovey B	Turkey Creek B	Vallecitos C	Volke C	Wark D
Summerville C	Tieton B	Tower D	Turnbow D	Valois C	Volney B	Warden B
Summit C	Tifton B	Towers B	Turner B	Vance C	Volperle C	Warman D
Summer A	Tijeras B	Townsburg B	Turnerville C	Vandallia C	Volusia C	Warne D
Sumter D	Tilden C	Townsend B	Tuscan B	Vanderville C	Vona A	Warners C
Sum D	Tillman B	Toxaway D	Tuscola B	Vanoss B	Vrooman B	Warrenton A
Sunbury B	Tilst C	Traer C	Tuscumbiz D	Varna C	Wacousta C	Warrior C
Suncok A	Timmer B	Transylvania B	Tusquibz D	Vaucluse C	Made D	Warsaw B
Sunderland C	Timmerman A	Trapper B	Tuxedo D	Vayas D	Madell D	Wartrace C
Suniland C	Timphute D	Travessilla D	Twin Creek B	Vega Alta C	Madena B	Warwick B
Sunnyside B	Timula B	Travis C	Twin Lakes B	Vega Baja D	Madesboro B	Washburn D
Sunrise B	Tinton B	Treadway D	Two Dot B	Vekol C	Madsouth D	Washington B
Sunsweet C	Tiocano D	Trego C	Tyler C	Velma B	Magner D	Washoe C
Superstition A	Tippah D	Trenary B	Udolpho C	Venango D	Maha C	Washougal C
Surry B	Tippah D	Trent B	Unita B	Venedy D	Wahee C	Washtenaw C
Susquehanna D	Tippecanoe B	Trexler C	Ulen B	Verdel D	Wahawa B	Wassiac C
Sutherland C	Tipperary A	Trinity D	Ulm B	Verdigris B	Wahum C	Wassuk D
Sutphen D	Tipton B	Tripp B	Ulupekua B	Verdun D	Wahua B	Watauga B
Sutton B	Tizah B			Vergennes D	Waikaloa B	Watchaug B
Swaim C	Tisbury B					Waterboro D